Math Labs: Teachers, Teacher Educators, and School Leaders Learning Together With and From Their Own Students

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Abstract

This article describes a structure for embedding professional development within a school day, which we call Math Labs. It enables teachers to come together, with the guidance of a teacher educator, to engage in collective inquiry into the teaching and learning of mathematics with time to experiment with new ideas with their own students. We explain the design principles, reflecting our commitments to equity and social justice, that motivate what occurs during a typical Math Lab. When Math Labs become an integral part of the school's culture, they allow teachers and school leaders to negotiate (1) how they position and empower students; (2) what opportunities they give students to learn rich mathematics; and (3) what shared professional values guide their inquiry into students' mathematical learning.

Introduction

We begin this article with a vignette to provide an image of what it might look like for teachers to work with their colleagues on complex aspects of mathematics teaching. The vignette features a professional learning structure called *Math Lab*, which is designed to support teachers to build their understandings and skills as teachers who center mathematics instruction on students' ideas, empowering students to meaningfully engage in learning mathematics.

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A group of third-grade teachers has planned a lesson together with their math coach to support students in making use of doubling when solving related multiplication problems. They are eager to see how their plans play out in a classroom visit and curious about what students will do. They have just posed 3 x 7 to one of their classes and plan to pose 6 x 7 next before moving on to a new set of problems with a doubling relationship (2 x 6; 4 x 6; and 8 x 6).

> *Savion, a third-grade student, is sharing how he thought about the problem 3 x 7: "I did seven and seven and seven, and got 21."*
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> *Mrs. Brown makes a "T" with her hands and says, "Teacher time out." She looks around the room at her third-grade teaching colleagues who are sitting among the students and asks, "How should I represent Savion's strategy? I'm not sure if we should use a number line or an array. We talked about both possibilities in our planning."*
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> *One of her colleagues suggests, "Let's ask him how he thought about it." Mrs. Brown smiles agreeing with this*

suggestion, looks at Savion and asks, "Savion, how were you picturing the sevens?" Savion again says, "I saw seven, seven, seven," and moves his hand horizontally each time he says seven, one seven below the next, as if they were stacked, moving it down a bit for each subsequent group of seven. Mrs. Brown revoices Savion's idea, saying, "It sounds like you were thinking of three rows of seven." He nods. She turns her attention back to her colleagues and says,"In our planning, we talked about moving away from directly modeling each item. I'm thinking I'll record this with the number 7 instead of dots. Does that sound okay?"

After seeing her colleagues nod in agreement, she draws the following:

7
7
7

She says, "Savion, does this match how you were thinking about it?" Savion nods his head and then Mr. Sampson signals a teacher time out and says, "One of our goals was to help students make sense of each other's ideas. What if we asked a question about Savion's strategy to the whole group? Maybe, 'How does Savion's picture help us figure out three times seven?'" Mr. Chen chimes in, "Or, we could ask, where do we see the three from three times seven in Savion's picture?"

After hearing from two students who suggested ways of using Savion's picture to solve the problem, Mrs. Brown returns to Savion and invites him to share how he thought about it. Mr. Sampson then trades places with Mrs. Brown and, as planned, takes over the facilitation of the lesson for the next part of the number string. He says, "Okay, I'm going to write the next problem in our string. I want you to ask yourself, 'Hmmm . . . can 3 x 7 help me think about this next one?'" He writes 6 x 7 on the chart paper and says, "Let's make sure everyone has some quiet think time. Show me a quiet thumb on your chest when you have an idea about 6 x 7."

As the lesson unfolds, Mrs. Brown, Mr. Chen, Mr. Sampson, and their colleagues work together to orchestrate a mathematical discussion, eliciting and responding to students' thinking. In this lesson, they use a particular instructional routine (i.e., number strings – posing related computation problems) as a focal point to learn more about their students' ideas (Fosnot & Dolk, 2001). They also want to develop shared practices that support students in developing identities as capable mathematicians and create classroom environments where students believe that who they are and how they think matter. Their students love having their ideas listened to by so many adults on these Math Lab days. The students see their teachers working hard at listening to and representing their ideas and strategies. The driving purposes of the teachers' collaboration enable them to move forward on their commitments to developing equitable learning environments.

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What are these teachers doing and how does this work benefit them and their students? Embedded within the school day, educators work together during Math Labs to plan, enact, and reflect on the work of teaching. A unique feature of Math Labs is to allow teachers the opportunity to immediately try out new ideas with their own students and reflect with their colleagues. Although Math Labs are facilitated by a teacher educator, such as a building or district coach or a university-based teacher educator, the facilitator is not an expert who is there to demonstrate "how to do it right." The structure organizes teachers' workplace interactions by giving them opportunities to engage in collective and ongoing inquiry into the teaching and learning of mathematics. Our goal in this article is to describe the Math Lab structure, the design principles that underlie the structure, and the potential of the structure to support learning and school improvement. The descriptions are based on our collective experiences facilitating Math Labs over the last decade. We conclude this article with data that convey the role Math Labs can play in school improvement.

Supporting Educators' Learning Together in Practice

Our goals for student learning in mathematics are complex, demanding, and even aspirational. Researchers in mathematics education have argued for a range of learning goals for students that attends to both procedural and conceptual fluency, engagement with disciplinary ways of knowing, and the cultivation of positive identities and agency with respect to using mathematics critically and meaningfully (Aguirre, Mayfield-Ingram, & Martin, 2013;

Gutiérrez, 2012; Gutstein, & Peterson, 2013; National Research Council, 2001; Turner et al., 2012). Goals for student learning have implications for what mathematics teachers need to know and be able to do, including cultivating learning environments in which students can do substantive mathematics and where students are treated as sense-makers and empowered to use mathematics in culturally meaningful ways.

Teaching mathematics is complex. It requires continual learning about the subject matter itself as well as how to make learning relevant and meaningful for particular students in particular contexts. Teachers must be adept at moment-to-moment decision making, in order to engage students in rich discussions of mathematical content (O'Connor & Snow, 2018). This type of instruction envisions that teachers orient students to each other's ideas and to the mathematical goal and position students competently (Kazemi, Franke, & Lampert, 2009). Teachers attend carefully not only to the way their students are making sense of mathematics but also to the way the students are relating to one another socially and mathematically. In addition, they focus on how students are able to bring their whole selves to the school. This means, for example, continually learning about the ways students see themselves with respect to race, culture, and gender. Teachers play significant roles in creating classroom learning environments that are inclusive, intellectually rigorous, and socioemotionally supportive (e.g., Aguirre et al., 2013; Franke, Kazemi, & Battey, 2007; Gutiérrez, 2012; Hunter & Anthony, 2011).

For us, this vision of mathematics teaching and learning pushes back against school structures and policies, often shaped by race, class, language, and/or gender, that have typically sorted and labeled children as being capable or not. We aim to create schools where children and adults are known and cared for and where they feel connected and invested (Martin, 2012). In order to support these communities and teachers in developing these types of instructional practices, we believe that schools need to be organized in ways that cultivate supports for teaching that aim to engage all kinds of learners successfully in complex mathematical learning—including adults and children.

The work described in this article is part of advancing an equity and social justice agenda, where both teachers' and students' experiences and knowledge are not seen as deficits but recognized as assets (Aguirre et al., 2013; Bartell et al., 2017; Turner et al. 2012).[1]

Over the past 10 years, we have worked alongside instructional coaches and teachers to design Math Labs and use them as a resource in creating thriving school communities. Math Labs are intended to support individual, group, and system learning in order to generate practices that continually renew and transform schools in ways that support the shared aims described above (Boreham & Morgan, 2004).[2] Therefore, Math Labs are most powerful when they include collaboration among classroom teachers, specialists teachers (e.g., ELL or SPED), mathematics coaches, and principals. At their best, Math Labs become an integral part of the school's fabric, allowing teachers and school leaders to negotiate (1) how they want to position students; (2) what opportunities they want to give students to learn particular mathematical content; and (3) the means by which to develop shared professional values through which they can discuss students' mathematical learning. Elsewhere we discuss how important the principal and coach are in embedding Math Labs in a broader view of supporting teachers' work lives and professional interactions (Gibbons, Kazemi, & Fox, 2017; Gibbons, Kazemi, & Lewis, 2017).

Designing Math Labs: Principles for Teaching and Learning to Teach

The Math Lab design is informed by a set of principles about both teaching (Figure 1) and learning to teach (Figure 2). These principles build on work that was concerned with supporting preservice teachers' learning in mathematics in which several authors were engaged (see Lampert et al., 2013) and have been further refined through collaboration with colleagues (Dutro & Cartun, 2016). The principles shape both the focus and structure of teacher learning during Math Labs. They are living principles in that they are refined and changed as communities learn. These principles convey that taking risks, being critical

[1] Although beyond the scope of this article, educators we have worked with have also used the Math Lab structure for teachers and families to engage in dialogue about the goals and processes of classroom instruction.

[2] Math Labs share many features with other professional development structures through which teachers inquire about their practice and get critical feedback, such as Lesson Study (Fernandez, 2002; Lewis, Perry, & Murata, 2006), video clubs (van Es & Sherin, 2010), cognitive coaching (West & Staub, 2003), and studio days (Teachers Development Group, 2010).

FIGURE 1.
Principles for teaching.

1. Teaching is both intellectual work and a craft. Deep knowledge of content and pedagogy, creativity, and passion fuel both learning and teaching.
2. Teachers must position students as sense-makers and knowledge-generators, who desire to invest and succeed in school. This involves building relationships with children, their families, and communities, as well as valuing their perspectives and attending to their thinking, curiosities, and capabilities.
3. Teachers must design equitable learning environments in which all children are engaged in robust and consequential learning.
4. Learning is a process of inquiry for both teachers and students. Teaching includes becoming a student of your students. Teachers must draw on multiple sources to deepen understanding of students as mathematics learners and how to support them to develop their mathematical knowledge and identities.
5. Teaching for equity involves analysis of language and positioning at three levels: individual, institutional, and societal. Our work together involves making the structures surrounding teaching and learning visible, thinking about how those structures impact individuals and groups, and working together toward action and advocacy.

about the impact of school structures and policies on students' experiences, and attending carefully to students are important in the process of growing as educators. They convey that inquiry is fundamental to learning and, at the same time, that communities develop when educators come together around shared experience.

Math Lab Structure

As we have come to know them, Math Labs involve small teams of teachers in full- or half-day, job-embedded experiences multiple times throughout the school year. Typically teachers in the same grade level come together for the experience, which is led by a mathematics coach. In our work, we have found it important for the principal to participate as a lead learner (Gibbons, Kazemi, & Lewis, 2017). Math Labs take place during the school day so that teachers and leaders can learn from students. For some schools, they have secured substitute guest teachers to be in the regular classroom teachers' rooms for the whole day. Other schools have found creative ways to cover classes for certain periods of time so that teachers can work together.

To support learning from the classroom experience, the work in a Math Lab is organized around a *learning cycle* with four phases: learning together, co-planning a lesson, enacting the lesson together, and debriefing together (McDonald, Kazemi, & Kavanagh, 2013). At the center of this learning cycle is an instructional activity that

FIGURE 2.
Principles for learning to teach.

1. Teaching is intellectual work and requires specialized knowledge.
2. Teaching is something that can be learned.
3. Learning to do something requires repeated opportunities to practice.
4. There is value in making teaching public.
5. We all bring our histories forward. Our own learning experiences and identities shape what we know and do. Our developing identities as mathematics teachers matter to our work with children.

provides the practical means for focusing student and teacher learning. The third phase of the Math Lab (i.e., enacting a lesson together) is what sets Math Labs apart from many other approaches to professional development. During these classroom enactments, teachers experiment together with new teaching practices and learn together about students' mathematical thinking. Like Lesson Study (Fernandez, 2002), teachers spend time together in classrooms. However, in a Math Lab teachers work together to experiment with instruction during *both* planning and the classroom enactment by collectively discussing instructional decisions in the moment (e.g., Gibbons, Kazemi, Hintz, & Hartmann, 2017). In what follows, we describe the norms required in this setting followed by each phase of a Math Lab, attending to what teachers do and the role that the facilitator might play in supporting them to collectively learn in and from practice.

Setting Norms for Experimenting with Practice Collectively

Asking teachers to experiment with new teaching practices collectively, with each other's students, can lead teachers to feel vulnerable. Teacher Educators must confront the challenge of designing learning spaces that are not typical in the current culture of U.S. schools, where teachers often work in isolation from one another. We have found that setting norms at the first Math Lab and continuing to revisit them over time is vital. Often facilitators will offer a provisional set of norms to the group of educators and ask for their reactions. Some example norms that we have seen facilitators use are provided in Figure 3. Facilitators will ask educators to read them and discuss with their colleagues what they might change, remove, or add to the list. They ask educators to reflect on which norms resonate with them and why.

FIGURE 3.
Sample norms used by facilitators.

• Be willing to take risks with new ideas.
• Listen actively and generously.
• Build on others ideas and invite others to participate.
• Give each other time to think and process ideas.
• Be open to sharing ideas in progress and revise your thinking.
• Use specific language to describe what you see students doing, rather than labeling students. Avoid labels such as "low" and "high."

At the beginning of each Math Lab thereafter, facilitators typically revisit norms with the educators. Sometimes, they ask educators to focus on a particular norm for that day's experience. We cannot overstate how important it is to attend to norms with educators. This allows facilitators to productively respond to the vulnerability that educators might feel around discussing and engaging in professional learning in new ways. In the following sections, we will also refer to other norms, specific to each phase, that we have found useful in enacting Math Labs.

Phase 1: Unpacking New Learning

A Math Lab begins with opportunities for collective learning about mathematics, student learning, and pedagogy. The intent of this phase is to support teachers' knowledge of mathematics, students' thinking, and pedagogy that supports listening and responding to students' thinking. For the sake of explaining what typically takes place in Phase 1, we tease apart each of these domains; however, they are often developed concurrently. What materials and ideas are explored during this phase depends on the overall plan for the team of teachers. For example, the teachers could be focusing on the teaching of a particular content domain or mathematical practice (e.g., properties of multiplication as depicted in the opening vignette or making use of structure). They could be working on integrating knowledge about supporting multilingual students with the teaching of mathematics or how to develop norms for advancing the rigor of classroom conversations while attending to how children use arrays to solve multiplication problems. The facilitator needs to consider a goal for teacher learning so that the Math Lab experience is coherent and reflects some intentionality about teachers' development.

Knowledge of mathematics. An important activity that takes place during this phase is engaging in mathematics content. The aim of engaging in mathematics is to challenge educators' specialized mathematical knowledge, which comprises the content knowledge and pedagogical skills required for effective teaching (Ball, Thames, & Phelps, 2008; Suzuka et al., 2010). To do so, the facilitator engages the group in rich explorations of mathematics, where the educators are placed in the role of students. This allows them to develop a stance of inquiry and cultivate a disposition that examines ideas. Further, engaging in the mathematical content will prepare them for Phase 2 in which they will anticipate students' strategies and consider how they might respond to those strategies. Educators may also examine content standards and discuss how the standards build on each other over time.

Knowledge of student thinking. In order to learn about how students' mathematical reasoning develops over time, facilitators engage teachers in reading articles from publications such as NCTM's *Teaching Children Mathematics* or books such as *Cognitively Guided Instruction* (Carpenter, Fennema, Franke, Levi, & Empson, 2014) or *Extending Children's Mathematics* (Empson & Levi, 2011). The facilitator leads discussions about what teachers learned in the readings about how students develop particular mathematical ideas and what tasks supported them to do so. Facilitators can also select video of students being interviewed by a teacher or engaging in mathematical discussions as a class. The educators can be asked to notice how students' ideas are developing, what language and tools they are using, and/or how their ideas are being taken up by the teacher or other students. This allows the educators to consider what they have just read against what they see students engaging in as they solve or discuss a particular task. Facilitators also support educators' understanding of student learning by engaging them in examining student work. Through examining student work, educators can learn how students' understanding of particular disciplinary ideas develop and also support educators in coming to appreciate the range of their students' ideas. In Phase 2, the educators can later consider how to build on those ideas during instruction.

Knowledge of pedagogy. Phase 1 provides the initial grounding for teachers to develop further understanding of a particular aspect of teaching and instructional decision making. Educators can raise questions about how teachers' actions might be consequential for students' experiences in the classrooms. Further, they may press each other's understandings of commitments around equity, and how these commitments come to life in the tasks on which they work with students and the way they conduct instructional conversations. Educators can consider the concept of voice, for example, and how students are positioned in the classroom and with what outcomes. They might then focus on one or two *talk* moves (e.g., revoicing or reasoning; Chapin, O'Connor, & Anderson, 2013) or moves that support linguistic development for English learners in order to consider how to use them during instruction to elicit and respond to students' ideas and to position students as capable and valued contributors to the classroom. To develop shared images of these practices, the facilitator might engage teachers in discussing classroom video, commercially or locally produced, or reading a case that gives a representation of a particular idea. The facilitator leads a discussion that highlights the focal ideas and supports educators to make sense of them in relation to goals for their own students.

Within Math Labs, we typically use routine Instructional Activities that provide a common focal point for teachers and instructional leaders to work together on teaching practices, student thinking, and mathematical content (Kelemanik, Lucenta, & Creighton, 2016; Lampert & Graziani, 2009). The Instructional Activity itself may be new to teachers, and facilitators choose to focus on supporting teachers to develop an understanding of the general contours of the activity and the mathematical opportunities generated by the activity. For example, if teachers were new to the number strings activity described in the opening vignette, the facilitator might engage teachers in this Instructional Activity as learners or the group might watch video of an example of a class engaging in the strings activity. The purpose of this kind of engagement is for teachers to experience the activity and begin to unpack the purpose of the activity in relation to its constituent parts (Grossman et al., 2009).

Facilitation of Phase 1. For each activity that a facilitator may choose to engage educators in during Phase 1, there are important norms to be established. The norms may vary, depending on the activity. For example, when doing mathematics, facilitators can share that they will press educators for an explanation about their work. Further, they can explain that mathematical errors can help examine further questions and ideas about mathematics. When viewing video, facilitators can encourage educators to be empathic with their observations of the classroom and in what the teachers and students are engaged and use their noticings to ask questions about their own classrooms. When analyzing student work, facilitators can encourage educators to focus on what students seem to be working on and thinking about. They can raise questions about what they want to understand further about the student but avoid evaluating the student.

Although we cannot detail facilitation practices around each activity, some literature exists to guide facilitators. For example, Little, Gearhart, Curry, and Kafka (2003) have identified a number of facilitation practices around the activity of examining student work. Elliott and colleagues (2009) and Borko, Koellner, and Jacobs (2011) examined facilitation practices that supported educators to engage in mathematics. van Es and colleagues (2014) have identified facilitation moves that supported educators to collectively examine and analyze video. White, Crespo, and Civil (2016) offer a number of cases for educators to consider how to engage in conversations regarding equity and justice in the context of teaching mathematics.

Phase 2: Co-Planning

Next, the group takes their new learning from Phase 1 and incorporates it into a process of collaboratively planning an instructional activity that they will soon enact together in a classroom. Selecting which task to do in the classroom with the group is often one of the most challenging aspects of planning Math Labs. Facilitators have to keep *both* teacher and student learning goals in mind when considering what they want the group of educators to try out together. Although the facilitator typically decides ahead of time the Instructional Activity in which the group and students will engage, the facilitator encourages the group to make the final decisions about the specific quantities, contextual features, and mathematical ideas they want to explore.

It is important that the group develops shared ownership of the lesson—it is not one teacher's lesson that is going to be modeled for others to observe. To plan for student learning, the group works together to first consider what they want to learn about students' mathematical thinking and then come to a consensus about a goal that might be productive for the students themselves. During this planning phase, the objective is not to plan a scripted, rigid lesson. Instead, lessons are planned with the intention for teachers to alter the flow of the lesson as they make sense of students' responses. The group works together to anticipate student thinking, and against this, they consider the affordances and constraints of particular instructional moves and representations they might use. The group brainstorms particular questions to uncover or press on student thinking. In some cases, this can include rehearsing some or all of the lesson (Lampert et al., 2013). For example, if the group is grappling with specific representations for a word problem, they may practice creating the representation during this phase in order to "work out the kinks" ahead of time. Alternatively, they may identify investigative questions they have and plan two different ways of representing—one during the first enactment and one during the second enactment.

Typically the group will spend 20-30 minutes preparing for their classroom visit. The group discusses not just what they will try but also to what they will attend. For example, while teachers might be planning an instructional activity that involves students using doubling as a strategy to multiply two numbers, they are also keeping in mind that as they try out the activity their goal will be to explore student understanding of and reasoning about how multiplication as an operation behaves. It is important for the plan to remain flexible enough that teachers can adapt instruction during the classroom visit in response to student thinking. To this end, teachers also make plans about how they will collaborate during the classroom visit. One or more teachers volunteer to take the lead on instruction during the visit, but the goal is for the visit to be collaborative. Teachers spend some time during Phase 2 establishing norms for their collaboration in the classroom. For example, teachers might agree on a way to chime in during instruction (see further discussion in Phase 3). They might also identify particular moments in the lesson about which they are curious or unsure to focus their noticing in the classroom visit. By the end of the planning time, teachers should have the basic flow of a plan written out and be ready to learn from how the students engage in that plan.

Phase 3: Co-enactment

With their co-planned lesson in hand, the group enters a classroom to try out the lesson. Classroom visits take place in the classroom of one or more participating teachers. The facilitator has negotiated which classroom(s) the group will visit and coordinated schedules with those teachers ahead of time. Although bringing the lesson to life is the responsibility of the group, the group determines who will take the lead for some or all of the lesson. Teachers typically do not take the lead in teaching when visiting their own classrooms. We have found this norm to be powerful for establishing a culture of risk-taking, because it helps reinforce the idea that the classroom visit is experimental in nature. When working with their colleagues' students, teachers seem more open to asking for input. This norm also provides a unique opportunity for the classroom teacher to be with her students and learn deeply about students' thinking without also being responsible for facilitating instruction.

When the educators enter the classroom, the group sits with and among the students in preparation for listening to and noticing carefully what the students say and do. The coach or principal starts by framing the visit for students by emphasizing that the teachers have spent the day learning together and that they are there to try out something new and to learn from the students. We have found this framing to be powerful for both teachers and students. Teachers are reminded that they are there as learners and no one is expected to model a perfect lesson. In addition, students are positioned as having important ideas that help their teachers learn.

Although there is a lead teacher who facilitates the lesson, a key element of classroom visits is that all of the educators in the group will collaborate *during instruction* to make decisions that are responsive to student thinking. Decision making is shared in the moment (as opposed to reflecting on and discussing decisions *after* the lesson is over) through an important routine called teacher time out (see Gibbons, Kazemi, Hintz, & Hartmann, 2017). By providing opportunities to pause within the lesson to think aloud, share decision making with one another, and determine where to steer instruction, teacher time outs help shift the focus of the classroom visit from one of judgment and evaluation to one of collective consideration about teaching and learning (Hiebert & Morris, 2012). For example, in the opening vignette, after Savion shared his strategy, Mrs. Brown (the lead teacher) paused to get a quick opinion from her colleagues about whether she should use a number line or an array to record his thinking. Later in the vignette, Mr. Chen (who was sitting among the students) initiated a teacher time out and suggested a question that could be asked in order to work towards the group's instructional goal.

There are often two classroom visits in one lab day so that multiple teachers can lead the Instructional Activity, and so the group has an opportunity to revise their plan based on what they learn in the first classroom visit and try out their revisions right away. It is the exploratory nature of the classroom visits, the dual focus on teacher and student learning, and the flexible use of classroom time that distinguishes our model from other professional development designs.

Phase 4: Debrief

Following the classroom visit(s), the teacher educator facilitates a debriefing conversation that focuses on what the team learned about students' thinking in relation to content, what this new learning means for instructional practice, and the implications for teachers' own classrooms. This often takes the form of a discussion that begins with prompts from the facilitator, but it can also include viewing video of the classroom visit(s) in order to revisit specific moments. We have found that it is important to start this debrief by asking what students seem to know or understand in relation to the content or instructional goal for the lesson. By starting the conversation with students' strengths, as opposed to limitations of students' understanding, teachers have an opportunity to develop their visions of students' mathematical capabilities (Jackson, Gibbons, & Sharpe, 2017) and consider how instruction can be responsive and build upon students' assets. As the group discusses what they noticed and wondered about students' thinking, the coach also encourages the group to consider instructional moves--both those that were made during the classroom visit as well as those that they could use in the future based on what they experienced in the classroom. The debrief typically ends with teachers making commitments about what they will try in their own classroom and when they will try it. By identifying when they are going to try something in their classrooms, both coaches and principals have the opportunity to ask, "Can I come try it with you?" or "How can I support you?" These common commitments provide opportunities for teachers to continue to learn about teaching mathematics between labs as they try common instructional activities and practices and share their experiences with their teammates, coaches, and principals. They can learn from one another about how these plans play out in their various classrooms.

Impact of Math Labs

Math Labs adhere to many recommendations of good professional development but as our previous description highlighted they have several unique features: (1) lessons worked on in Math Labs are typically activities that teachers can use routinely across the school year and across grades; (2) plans for teaching these activities are collectively created and owned by the participating mathematics teachers; (3) the teacher educator attends to teacher learning goals and serves not as the sole authority but instead as someone who invites teachers to experiment in planning and enacting lessons; and (4) during enactments, teachers make their decision making public with one another and can collectively steer the lesson through the use of teacher time outs as they make sense of student thinking. When Math Labs are used intentionally within schools, these unique features positively impact teachers' learning and growth. As evidence of this impact, in the following sections we share the voices of educators who have participated in Math Labs, relying on interviews conducted with teachers and school leaders. The educators were asked to describe their experiences with Math Labs and how they influenced their understanding of teaching mathematics and instructional leadership as well as their relationships with their colleagues. In addition to teacher learning, we have also seen significant growth in children's learning. We conclude this section with a description of this evidence.

Teachers' Experience and Learning

When asked to reflect on their experiences in Math Labs, participants' responses fell within four broad categories: the focus on Instructional Activities, multiple enactments of Instructional Activities, shifts in perspectives of student capabilities, and collaborative enactments. Each of these categories will be described in the following sections.

The focus on Instructional Activities. When asked about their participation in Math Labs, teachers reflected on the power of centering the experience around Instructional Activities. Teachers shared how these activities provide different kinds of experiences for their students because they: (a) have multiple entry points often with many ways for students to be correct or to be successful; (b) afford many opportunities for students' voices to be heard; and (c) offer students the opportunity to engage in rich mathematical practices beyond recalling and practicing procedures. The use of Instructional Activities encouraged teachers' experimentation and practice with similar routines multiple times and with different content objectives. Teachers noted that as a result of this practice they felt more prepared to try things on their own in their classrooms. In particular, having opportunities to plan for and try particular kinds of conversations associated with each Instructional Activity helped teachers feel more prepared to do the same on their own. As one teacher explained, "I think a lot of people would have tried an [Instructional Activity] but I don't know that it would have been implemented in the way that it's intended without the professional development or the space to try it and see what it looks like."

In addition, teachers who experienced Math Labs across grade levels in a school reported that the focus on Instructional Activities supports a feeling of coherence across the school. One kindergarten teacher described a moment when she realized how Instructional Activities had changed the kinds of conversations she could have with colleagues.

> We spent one of our staff meetings . . . talking about what was going well. And I was sharing about an Instructional Activity in my classroom that had been going well, and then one of the fifth-grade teachers – she was sharing about the same Instructional Activity but happening in fifth grade . . . And we were able to have a conversation about the same activity at different ends of the spectrum . . . It was really cool because I couldn't have had that conversation [before Math Labs].

The focus on Instructional Activities seemed to support teacher learning in a way that helps them to feel more prepared for implementing what they are learning about mathematics instruction in their own classrooms and to develop a sense of alignment with their colleagues.

Multiple enactments of instructional activities. In their reflections and interviews, teachers also highlighted how having multiple opportunities to enact the same Instructional Activity together supported their learning. Math Labs gave them "space to try it and see what it looks like in practice." Teachers often highlighted this chance for multiple enactments as the key difference from other professional development experiences. One teacher told us, "It's not like another [professional development] where you go and you listen and you hear about this stuff and then you happen to remember weeks later you can apply it in your situation." Teachers described how the experience supports them to be more comfortable with improving how they make sense of students' ideas. One teacher reflected, "Getting the chance to see kids in the moment. And be really responsive with those lessons when you try something out and then reflecting on it. . . Getting to do that with kids live, is priceless." Teachers also get a chance to try out new activities with support rather than trying them alone in their own classrooms. One teacher explained how different it would be to only receive instructions on how to do an Instructional Activity without trying it out. "None of us like to get up in front of the class and struggle through something and not know what we're doing . . . So the Labs, I think, make us better prepared."

Shifts in perspectives. What seemed to be powerful for teachers was that the interactions they have with students shift because of what they experience during Math Labs. Teachers described seeing that students are more capable of engaging in rigorous mathematical activity and discourse than they thought. For example, one teacher described the impact of seeing a colleague supporting students to engage in a rich conversation. "And when you see someone who is being successful with the same group of kids I have, [I ask myself]--what are they doing that I'm not doing yet? . . . Just really seeing that I need to push myself more to draw out more from my students, more discussion, more thinking." Teachers described the experiences as sparking new awareness of their students' mathematical capabilities and challenging the preconceived notions they have about their students' capabilities. For example, one teacher described observing a colleague ask a student questions that she would not have thought of, which revealed aspects of the student's thinking she would not have expected. In this way, Math Labs offered teachers an opportunity to be in classrooms with students as learners, which enabled them to see their learners in new ways.

Collaborative enactments. A key element of the enactments in classrooms for teachers was that they feel truly collaborative in nature. Teachers described a willingness to take risks in the classroom alongside their colleagues. As one teacher described, "Being flexible is a huge part of a Math Lab. Being open to your colleagues' thoughts and opinions about what they think you should try next or what you should do to make it better." Teachers often highlighted this as a key difference for them from other professional development experiences. "I really felt okay to make mistakes. I've been in some other [professional development] where I felt like the response was, 'Oh, she's just not getting it, she's not doing it right.'" For teachers, this experimentation with colleagues can change how they feel about their own practice in their classrooms. Teachers described how Math Labs help them feel more willing to talk with colleagues and administrators outside of the professional development session about challenges they are facing in the classroom. As one teacher reflected, "Practicing together has taught me, we're okay making mistakes. We all make mistakes. And we're not perfect, just because we're teachers."

Student Learning

We have had the opportunity to document some aspects of student learning through our collaborations with schools and districts who use Math Labs. We do not claim, however, that Math Labs by themselves produce gains in student learning. We do believe, though, that they can be part of intentional and long-term plans for transforming instruction and creating meaningful workplace learning opportunities for teachers. With that caveat, we have seen significant changes in student learning.

In one diverse urban school serving students from communities who have been historically marginalized, where all teachers (K-5) participated in an average of six Math Labs each school year across three years and had considerable supports from school leaders, students' standardized test scores improved from the 5th percentile in the state to the 78th percentile in three years. In the same school, achievement gaps between black and white students and between English speakers and bilingual speakers diminished significantly or were closed in that same period of time. We also interviewed students about their mathematical thinking at five different points in time over three years (Kazemi, Gibbons, Lomax, & Franke, 2016). Students' responses showed dramatic improvement in both accuracy and sophistication of strategies at each grade level. Third- through fifth-grade students, whose teachers focused on fractions much of the time in Math Labs, showed marked growth in their understanding of fractions. An analysis of students' responses to an equal sharing fraction task (Lewis, Gibbons, Kazemi, & Lind, 2015) revealed that students in three different cohorts developed more sophisticated strategies for partitioning and sharing, created more accurate representations of their partitions, and used more accurate fraction language and notation (Lewis, 2016). That analysis also found that at the start of each subsequent school year, the cohort of students entering a particular grade level brought with them more sophisticated strategies for partitioning and sharing as well as more accurate representations. This range of ways of measuring achievement cannot convey the full story of the experience teachers and students had at this school as they transformed the school culture into a place where students and teachers felt heard and seen. Still, these achievement gains are consequential for students.

Facilitation Demands

Our studies of school improvement have clearly shown that Math Labs are not a silver bullet to be mechanically implemented in order to change school cultures and students' learning experiences. Math Labs can serve, though, as an important part of transforming school cultures towards more equitable learning environments for students who have been historically marginalized. We end this article with observations about key facilitation demands of Math Labs. Getting Math Labs off the ground takes intentional work setting norms of risk-taking and deprivatizing practice. The facilitator plays an important role in shaping the tone of Math Labs and the vulnerability that teachers experience. The teacher educator also sets the tone for students during classroom visits by positioning students as important contributors to teachers' learning. To help do this important work, we have found that facilitators need to develop familiarity and adeptness with the Instructional Activities used in Math Labs. Visiting teachers' classrooms independently of Math Labs to try out Instructional Activities and to model the kind of back and forth exchange that characterizes teacher time outs is important to establishing productive relationships with teachers and students. To make good choices in identifying teacher learning goals in Math Labs, this experience in teachers' classrooms is vital for facilitators, because discussions in Math Labs are informed with particular teachers' and students' needs in mind.

Conclusion

For Math Labs to be consequential over the long term, our studies of teacher learning have indicated that building leaders coordinate the work in Math Labs with other collaborative spaces in the school such as faculty meetings, grade-level meetings, and individual coaching support (Gibbons, Kazemi, & Fox, 2017; Gibbons, Kazemi, & Lewis, 2017). Math Labs, by themselves, are not a comprehensive solution to teacher learning needs. Our studies have also shown that Math Labs require skilled facilitation (Fox, 2018). Not surprisingly, shifts occur in how teachers and facilitators talk about practice as they learn together over time. At first, teachers and facilitators may focus more on technical aspects of what the Instructional Activities are or grapple with how to elicit students' ideas. Over time, though, as participants develop norms of trust and experimentation, they can pursue more complex and persistent problems of practice, develop more coherent instructional practices within and across grade levels, and tackle emerging questions about student learning (Rigby, Kazemi, Lenges, Forman, & Fox, 2018). Like all efforts to achieve equitable learning experiences of students, Math Labs can be a useful resource if teachers and students are empowered to experience school as spaces where their ideas are heard.

AUTHOR NOTE:

Math Labs have inspired ways of structuring professional learning in other areas. At the University of Washington, we have adapted Learning Labs for (1) science, literacy, and social studies professional learning; (2) mentor professional development in teacher preparation; (3) incorporating technologies into teaching; and (4) learning culturally responsive and anti-oppressive pedagogies. We have begun to develop tools for teacher educators and school leaders who wish to implement similar professional learning opportunities for teachers. For resources to support facilitating Math Labs, go to TEDD.org and explore the following sections:

- Setting norms
- Facilitating Collaborative Planning
- Rehearsals
- Teacher time out
- Planning labs

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